

# **August 1997**

## **Preliminary Data Summary**

by      Field Research Facility

U.S. Army Corps of Engineers  
Waterways Experiment Station  
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# Preface

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This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

**Data from these reports are now available via the World Wide Web at**  
**<http://www.frf.usace.army.mil>**

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and suggestions are welcome.

# Introduction

## 1

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The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919)261-6840 ext.222 ([c.baron@cerc.wes.army.mil](mailto:c.baron@cerc.wes.army.mil)).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).

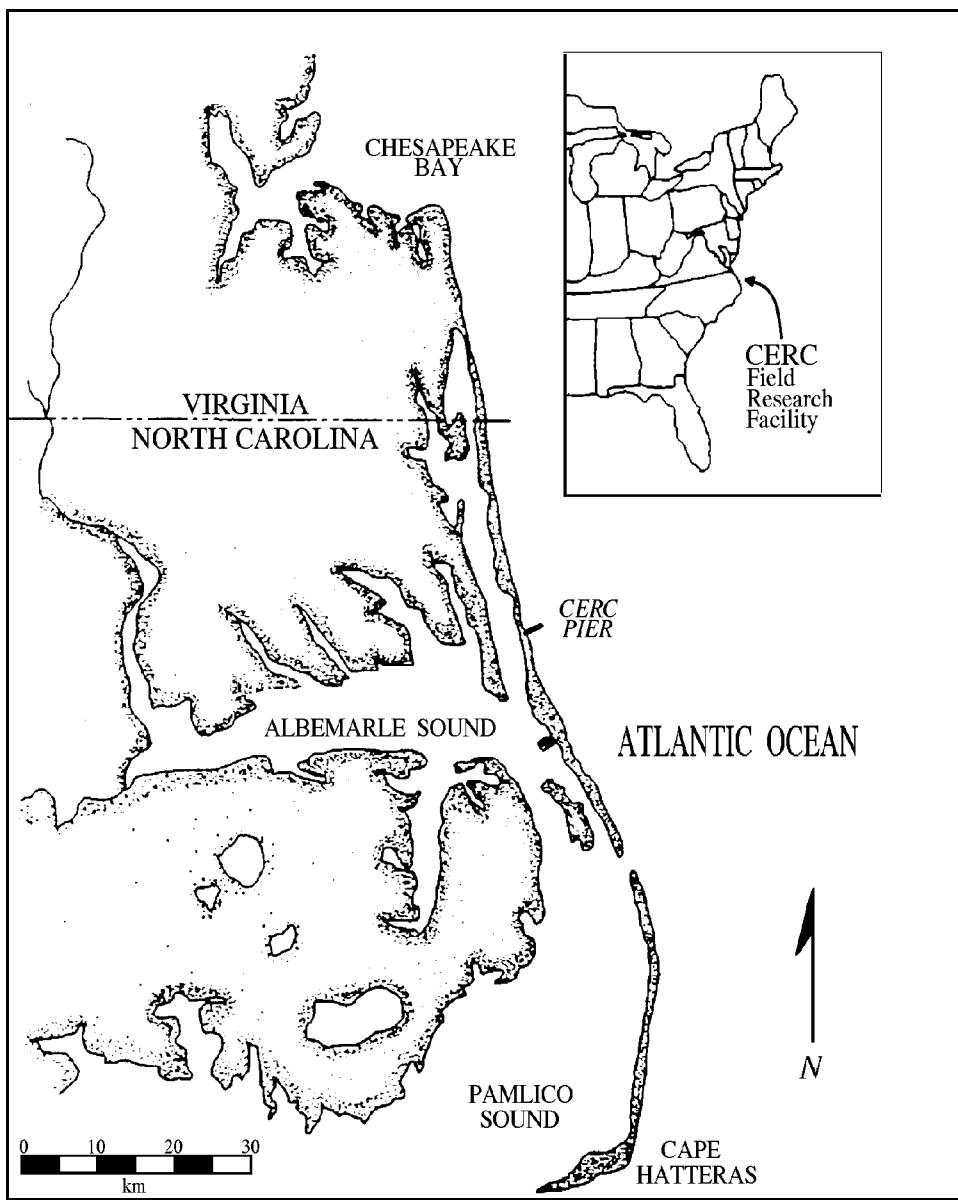


Figure 1. FRF Location Map

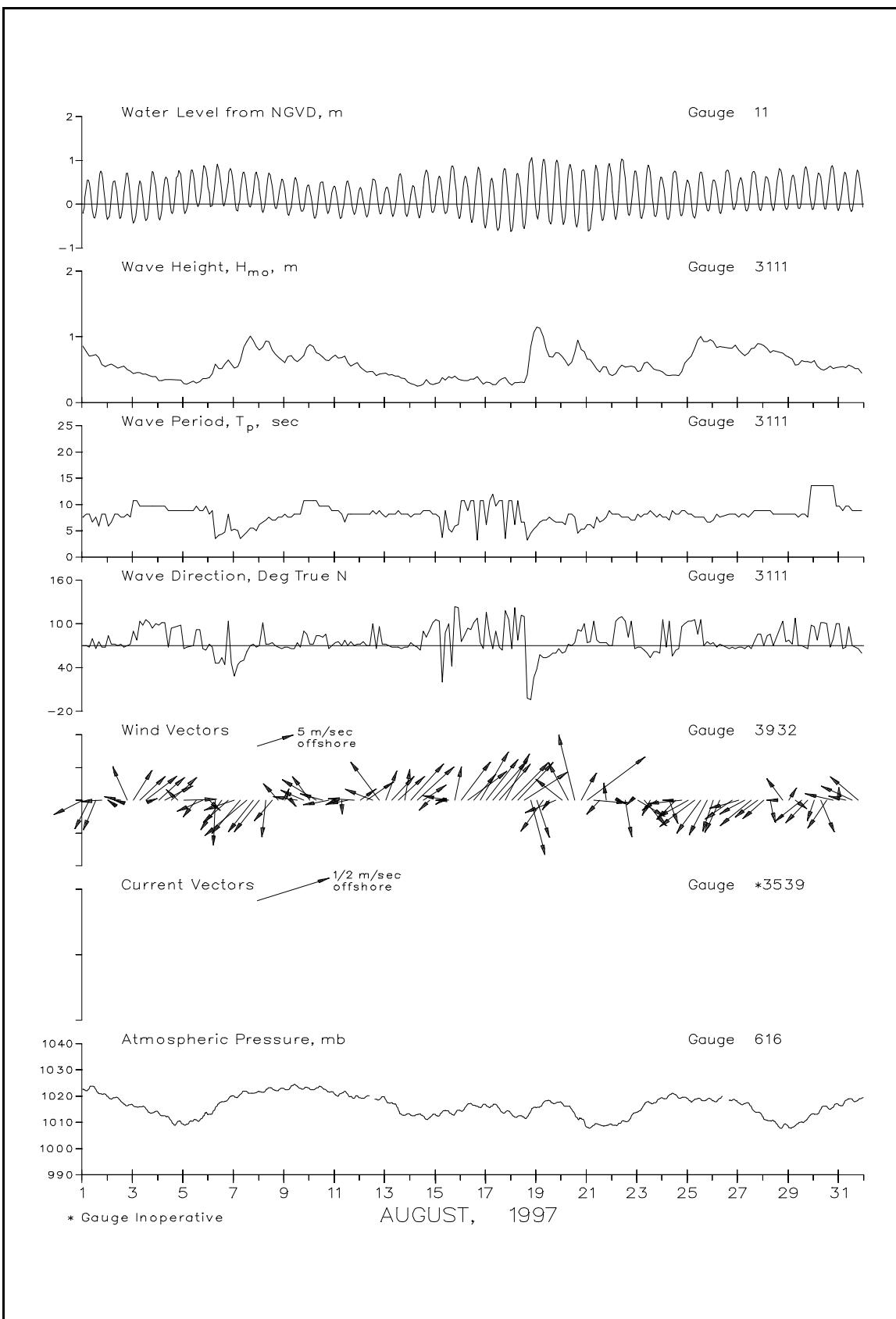


Figure 2. Month at a Glance

**Table 1**  
**Instrument Status/Data Availability**

		August 1997																															
		Day of the month																															
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																										
Data Collected		*	= All	/	= Partial	-	= None																										
Visual Observations		*	= Complete	/	= Partial	-	= None																										

**Table 2**  
**Gauge Locations**

Gauge*	Description	* Latitude	* Longitude	* FRF Coordinates	* Gauge Depth	* Water Depth
ID *		* Degrees N	* Degrees W	* Crossshore	* Longshore	* NGVD, m
		*	*	m	m	*
616	* Atmospheric Pressure*	36 10' 57.03"	* 75 45' 5.50"	* 11.60	* 569.00	* -----
	*	*	*	*	*	*
3932	* Anemometer	* 36 11' 1.23"	* 75 44' 43.07"	* 585.20	* 517.30	* 19.50
	*	*	*	*	*	*
641	* Pressure Gauge	* 36 10' 57.71"	* 75 44' 56.23"	* 239.11	* 516.64	* -1.64
	*	*	*	*	*	*
625	* Baylor Staff	* 36 11' 1.04"	* 75 44' 43.72"	* 568.00	* 516.64	* Surface
	*	*	*	*	*	*
3111	* 8 Meter Array North	* 36 11' 19.14"	* 75 44' 36.41"	* 915.23	* 990.16	* -7.50
	*	*	*	*	*	*
	* 8 Meter Array South	* 36 11' 11.28"	* 75 44' 33.28"	* 914.20	* 735.37	* -7.42
	*	*	*	*	*	*
	* 8 Meter Array East	* 36 11' 13.70"	* 75 44' 32.56"	* 954.51	* 800.58	* -7.62
	*	*	*	*	*	*
	* 8 Meter Array West	* 36 11' 12.48"	* 75 44' 37.11"	* 834.66	* 800.37	* -6.98
	*	*	*	*	*	*
111	* Pressure Gauge in center of 8 M Array	* 36 11' 14.06"	* 75 44' 34.39"	* 914.43	* 825.52	* -7.76
	*	*	*	*	*	*
630	* Waverider Buoy	* 36 10' 5.10"	* 75 41' 59.30"	* 3934.96	* -2400.81	* Surface
	*	*	*	*	*	*
3539	* Current Meter	* 36 11' 23.57"	* 75 44' 9.12"	* 1605.80	* 907.60	* -11.60
	*	*	*	*	*	*
11	* NOAA Tide Gauge	* 36 11' 1.25"	* 75 44' 42.60"	* 596.49	* 514.20	* Surface
	*	*	*	*	*	*
R	R	R	R	R	R	R

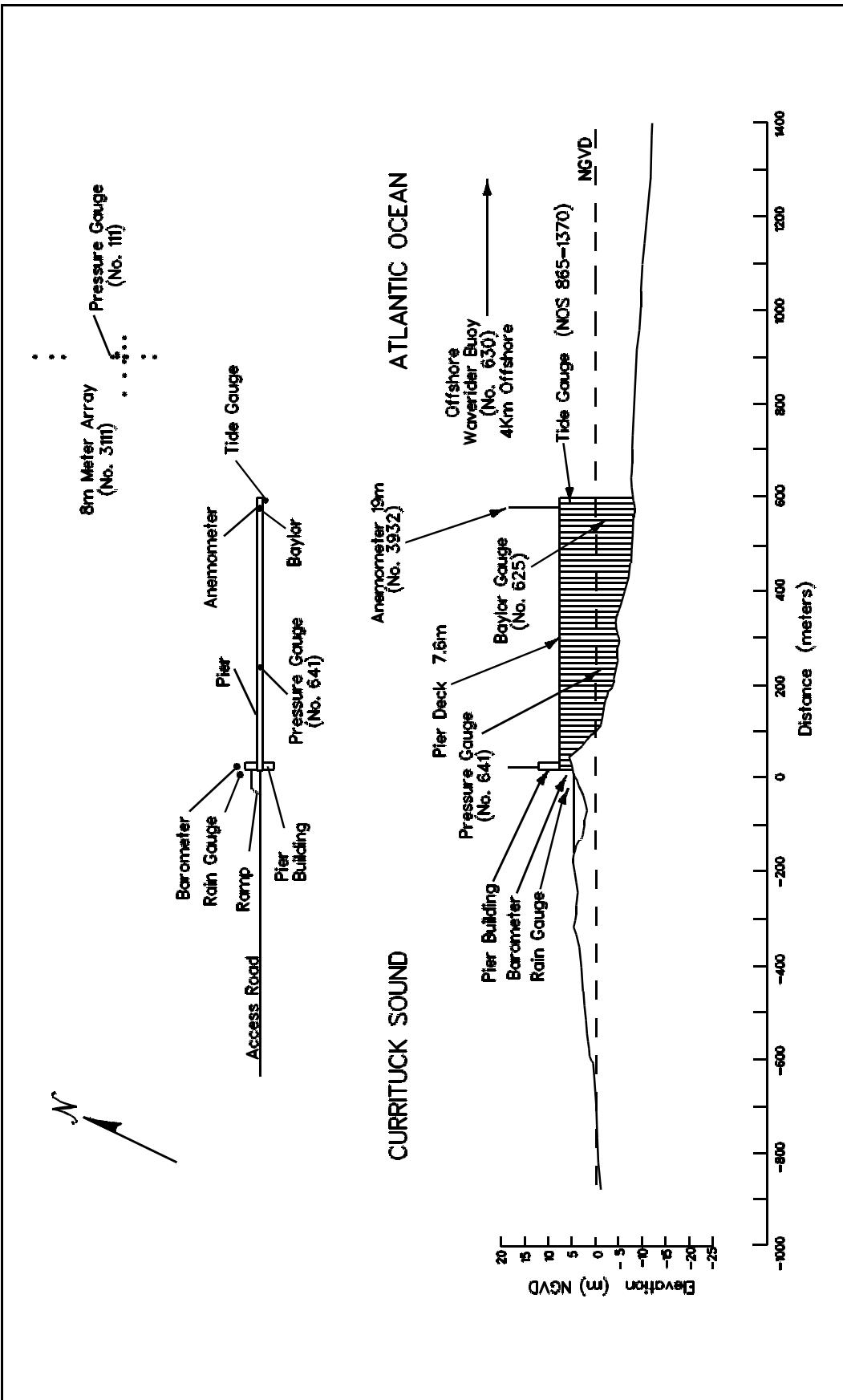


Figure 3. Instrument Locations, Elevations From NGVD

# Meteorological Data

## 2

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A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

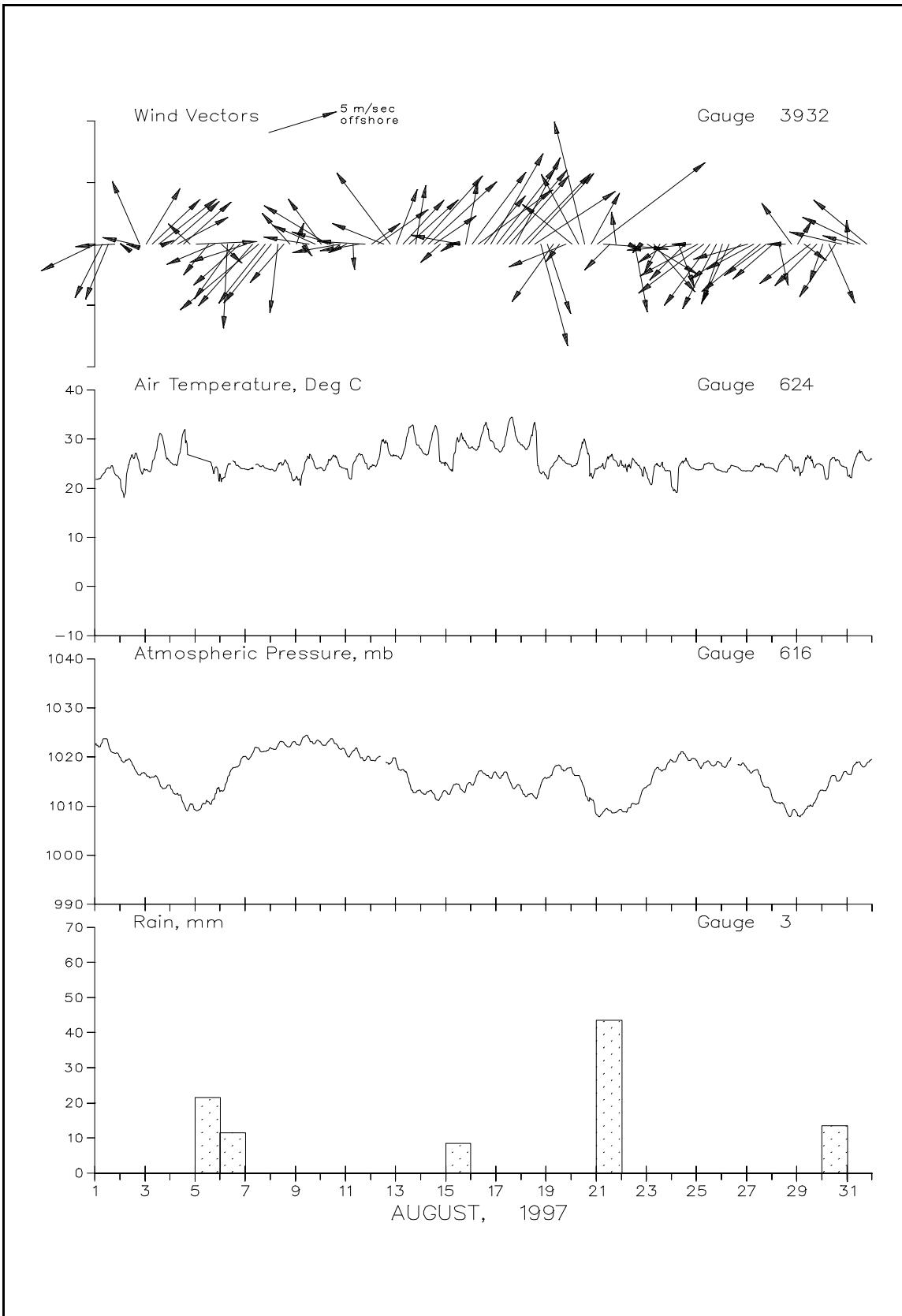


Figure 4. Meteorological Monthly Summary

**Table 3**  
**Meteorological Data**

Aug 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	4	60	21.8	1022.7	0
	700	5	23	22.7	1023.1	0
	1300	5	19	24.2	1022.7	0
	1900	3	85	22.9	1020.8	0
2	100	0		20.2	1019.6	0
	700	0		23.7	1019.4	0
	1300	2	103	26.1	1018.2	0
	1900	5	159	24.3	1016.4	0
3	100	5	208	23.7	1016.5	0
	700	5	222	25.0	1016.0	0
	1300	5	227	30.4	1015.2	0
	1900	1	245	27.9	1013.7	0
4	100	5	224	25.2	1013.6	0
	700	4	238	24.8	1012.6	0
	1300	5	224	31.5	1010.7	0
	1900	2	137		1010.4	0
5	100	4	1	inoperative	1009.1	0
	700	3	321		1010.6	21
	1300	3	34		1010.9	0
	1900	4	63	24.0	1012.0	0
6	100	2	316	21.3	1013.2	0
	700	7	2	24.5	1015.7	11
	1300	5	31	25.4	1017.9	0
	1900	5	44	24.1	1018.9	0
7	100	4	69	23.8	1019.9	0
	700	6	37	24.1	1020.8	0
	1300	8	45	24.7	1021.8	0
	1900	6	34	24.1	1021.2	0
8	100	6	34	23.8	1021.7	0
	700	6	5	24.5	1022.4	0
	1300	4	37	25.2	1023.0	0
	1900	3	141	23.4	1022.1	0
9	100	2	197	22.4	1022.7	0
	700	1	326	23.2	1023.9	0
	1300	3	100	26.0	1023.8	0
	1900	3	116	24.3	1022.8	0
10	100	4	147	24.1	1022.7	0
	700	5	124	24.8	1023.1	0
	1300	3	1	26.8	1023.1	0
	1900	3	78	24.4	1021.6	0

**Table 3**  
**Meteorological Data (continued)**

Aug 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	1	60	23.9	1020.6	0
	700	2	1	24.9	1021.2	0
	1300	3	78	27.1	1020.7	0
	1900	3	93	25.2	1019.3	0
12	100	3	229	24.4	1019.4	0
	700	4	231	25.6	1020.0	0
	1300	4	114	29.4	1018.9	0
	1900	7	146	26.8	1018.7	0
13	100	5	197	26.5	1018.7	0
	700	5	218	26.9	1017.5	0
	1300	5	223	32.3	1014.9	0
	1900	5	188	30.0	1012.8	0
14	100	7	217	27.8	1012.7	0
	700	7	223	27.0	1013.0	0
	1300	4	231	32.1	1012.4	0
	1900	2	43	25.5	1011.9	0
15	100	0		25.0	1012.8	0
	700	1	54	24.4	1014.1	8
	1300	3	101	29.7	1014.2	0
	1900	5	189	29.4	1013.3	0
16	100	7	212	28.5	1014.3	0
	700	7	229	28.4	1017.0	0
	1300	5	216	32.9	1016.6	0
	1900	8	206	29.7	1015.8	0
17	100	7	213	28.0	1016.4	0
	700	7	216	28.2	1016.4	0
	1300	7	216	33.7	1015.4	0
	1900	8	204	30.8	1013.9	0
18	100	7	220	28.9	1013.1	0
	700	7	218	28.4	1012.4	0
	1300	7	232	33.4	1011.8	0
	1900	8	347	23.0	1014.3	0
19	100	6	343	22.0	1015.7	0
	700	6	31	24.7	1017.5	0
	1300	2	33	26.4	1018.3	0
	1900	4	65	25.1	1017.3	0
20	100	5	132	24.4	1017.3	0
	700	6	155	26.1	1016.2	0
	1300	10	167	29.7	1013.3	0
	1900	5	205	23.0	1011.5	0

**Table 3**  
**Meteorological Data (concluded)**

Aug 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	10	228	24.0	1008.2	0
	700	5	275	24.2	1008.9	44
	1300	3	39	26.5	1009.1	0
	1900	3	172	25.5	1008.8	0
22	100	0		24.6	1009.1	0
	700	1	301	24.4	1009.7	0
	1300	6	351	25.5	1010.5	0
	1900	1	39	23.8	1012.4	0
23	100	4	304	22.6	1014.1	0
	700	5	323	23.6	1016.9	0
	1300	3	25	24.4	1017.5	0
	1900	2	52	23.5	1018.0	0
24	100	0		20.1	1019.3	0
	700	4	342	24.1	1020.3	0
	1300	4	40	25.5	1020.6	0
	1900	5	83	24.2	1019.5	0
25	100	5	57	23.7	1018.9	0
	700	6	48	24.6	1018.8	0
	1300	6	32	25.0	1018.8	0
	1900	6	24	23.9	1018.8	0
26	100	5	16	23.4	1018.3	0
	700	5	21	23.9	1019.1	0
	1300		Inoperative			0
	1900	5	51	23.6	1018.4	0
27	100	4	72	23.5	1017.5	0
	700	4	58	24.1	1017.2	0
	1300	6	46	24.6	1016.2	0
	1900	4	49	24.2	1013.9	0
28	100	4	44	24.0	1011.3	0
	700	3	349	24.7	1010.7	0
	1300	1	90	26.9	1009.6	0
	1900	4	147	25.5	1008.4	0
29	100	2	207	24.3	1008.1	0
	700	2	310	24.6	1008.8	0
	1300	5	47	26.2	1010.3	0
	1900	4	40	24.9	1011.6	0
30	100	3	16	24.5	1013.2	0
	700	5	339	23.8	1015.0	14
	1300	5	30	25.7	1016.2	0
	1900	4	104	24.6	1015.9	0
31	100	2	177	22.6	1016.6	0
	700	2	106	25.0	1018.4	0
	1300	5	118	27.2	1018.9	0
	1900	5	133	25.7	1018.7	0
Resultant			Mean	Mean	Total	
1		102	25.5	1016.2	98	

# Wave Data

## 3

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Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4**  
**Wave Data**

Aug 1997											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
1	0100	0.20	8.9	0.44	8.9	0.86	7.6	70	1.12	7.2	
	0700	0.36	5.3	0.66	8.3	0.70	8.2	68	0.86	6.7	
	1300	0.34	6.5	0.73	6.1	0.73	7.6	66	0.88	6.3	
	1900	0.32	5.7	0.55	6.8	0.58	8.2	68	0.77	5.3	
2	0100	0.23	6.0	0.52	6.0	0.57	5.9	84	0.68	7.7	
	0700	0.26	5.4	0.50	8.3	0.55	8.2	72	0.67	8.4	
	1300	0.23	8.3	0.48	7.2	0.54	7.6	72	0.61	7.7	
	1900	0.28	8.1	0.46	8.1	0.50	8.2	70	0.67	8.4	
3	0100	0.20	9.2	0.37	9.2	0.44	10.8	90	0.52	8.4	
	0700	0.25	10.3	0.38	10.7	0.45	9.8	104	0.53	10.6	
	1300	0.18	10.3	0.36	9.5	0.43	9.8	106	0.44	10.1	
	1900	0.25	9.5	0.36	9.9	0.39	9.8	94	0.43	10.1	
4	0100	0.15	9.2	0.31	9.5	0.34	9.8	98	0.39	9.1	
	0700	0.20	9.5	0.28	9.5	0.34	9.8	102	0.37	9.1	
	1300	0.14	8.9	0.31	8.9	0.35	8.9	94	0.39	10.1	
	1900	0.20	9.5	0.33	9.2	inoperative			0.43	9.1	
5	0100	0.16	9.5	0.28	9.5	0.29	8.9	66	0.44	9.1	
	0700	0.19	9.1	0.31	8.0	inoperative			0.45	9.1	
	1300	0.16	15.1	0.31	9.9	0.29	9.8	92	0.44	10.1	
	1900	0.23	14.3	0.37	9.5	0.37	8.9	66	0.50	10.1	
6	0100	0.22	13.5	0.36	9.9	0.38	8.2	72	0.45	10.1	
	0700	0.37	3.9	0.53	4.1	0.58	3.5	46	0.78	3.8	
	1300	0.36	4.5	0.49	4.1	0.52	4.4	54	0.74	4.6	
	1900	0.53	5.4	0.61	5.2	0.65	8.2	104	0.83	4.8	
7	0100	0.41	5.4	0.54	4.7	0.53	5.3	28	0.70	5.1	
	0700	0.44	5.1	0.61	4.8	0.64	3.5	48	0.76	5.1	
	1300	0.55	4.7	0.88	4.7	0.93	4.8	62	1.11	4.8	
	1900	0.53	5.0	1.02	5.3	0.94	5.6	72	1.16	5.3	
8	0100	0.38	6.8	0.79	5.1	0.80	6.2	70	1.00	5.3	
	0700	0.41	7.2	0.87	7.6	0.94	7.1	72	1.14	7.2	
	1300	0.37	6.8	0.78	7.2	0.80	7.1	74	1.05	6.7	
	1900	0.30	7.8	0.66	7.4	0.69	7.6	68	0.85	7.7	
9	0100	0.25	7.8	0.56	7.6	0.61	8.2	68	0.74	7.2	
	0700	0.31	7.8	0.68	7.8	0.71	7.6	66	0.77	7.7	
	1300	0.27	8.1	0.50	8.3	0.63	8.2	74	0.67	7.7	
	1900	0.29	11.2	0.62	11.2	0.72	10.8	90	0.76	11.2	
10	0100	0.40	11.7	0.75	11.2	0.88	10.8	72	0.87	10.6	
	0700	0.29	10.7	0.66	10.3	0.76	10.8	84	0.81	10.1	
	1300	0.33	10.3	0.58	10.3	0.69	9.8	82	0.75	10.1	
	1900	0.25	9.9	0.50	9.5	0.63	9.8	66	0.67	10.1	

**Table 4**  
**Wave Data (continued)**

Aug 1997										
Day	Hour	641		625		3111			630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec
11	0100	0.38	7.8	0.60	9.5	0.73	8.9	74	0.84	9.1
	0700	0.31	5.9	0.65	8.9	0.69	8.2	70	0.83	8.4
	1300	0.36	6.8	0.52	8.3	0.61	8.2	70	0.67	9.1
	1900	0.26	8.3	0.54	8.3	0.58	8.2	70	0.64	7.7
12	0100	0.25	7.6	0.50	7.8	0.54	8.2	72	0.62	6.7
	0700	0.18	8.1	0.43	8.6	0.46	8.2	70	0.52	8.4
	1300	0.20	8.3	0.39	8.3	0.47	8.9	100	0.48	8.4
	1900	0.22	8.6	0.43	8.6	0.43	8.9	96	0.49	8.4
13	0100	0.21	7.6	0.39	6.6	0.45	7.6	72	0.52	7.7
	0700	0.16	6.6	0.39	6.6	0.42	8.2	68	0.46	6.7
	1300	0.21	8.1	0.35	8.3	0.40	8.9	68	0.41	8.4
	1900	0.17	9.2	0.33	8.1	0.36	8.2	68	0.48	7.7
14	0100	0.16	7.4	0.25	7.4	0.29	7.6	74	0.40	6.7
	0700	0.13	14.3	0.23	7.8	0.25	8.2	68	0.37	7.7
	1300	0.16	14.3	0.24	8.1	0.28	8.9	90	0.29	12.6
	1900	0.18	15.1	0.27	15.1	0.29	8.9	92	0.40	9.1
15	0100	0.16	14.3	0.24	8.6	0.28	8.2	106	0.35	8.4
	0700	0.25	4.2	0.35	3.9	0.38	3.8	20	0.51	4.1
	1300	0.28	5.0	0.47	4.7	0.39	5.3	100	0.58	4.8
	1900	0.30	5.2	0.43	3.8	0.40	5.9	124	0.41	4.8
16	0100	0.19	6.5	0.37	5.9	0.34	10.8	76	0.54	6.3
	0700	0.19	6.8	0.29	9.2	0.34	8.9	94	0.44	6.7
	1300	0.20	6.0	0.36	10.3	0.35	10.8	102	0.45	5.9
	1900	0.22	10.7	0.36	4.2	0.33	10.8	74	0.61	4.4
17	0100	0.15	6.5	0.29	6.3	0.31	6.2	116	0.42	10.1
	0700	0.18	10.7	0.27	10.3	0.28	12.0	66	0.43	10.6
	1300	0.17	9.9	0.35	9.9	0.33	10.8	68	0.41	10.1
	1900	0.24	10.7	0.39	3.6	0.38	3.5	118	0.53	3.6
18	0100	0.14	6.0	0.28	6.1	0.27	10.8	66	0.48	10.6
	0700	0.21	6.1	0.33	9.9	0.30	10.8	78	0.47	6.3
	1300	0.17	6.8	0.30	6.8	0.30	6.6	110	0.46	6.7
	1900	0.56	5.0	0.77	4.4	0.85	4.6	356	0.98	4.2
19	0100	1.07	5.7	0.99	5.6	1.15	5.9	38	1.39	5.9
	0700	1.08	7.4	1.03	7.0	1.01	7.1	54	1.60	6.3
	1300	0.51	6.5	0.67	7.2	0.70	7.6	56	0.89	7.2
	1900	0.54	5.7	0.70	7.0	0.76	6.6	60	0.88	6.7
20	0100	0.36	6.3	0.70	6.3	0.69	6.6	60	0.88	6.3
	0700	0.35	6.3	0.58	7.0	0.56	8.2	72	0.81	7.2
	1300	0.36	4.0	0.76	3.8	0.76	7.6	74	0.89	3.6
	1900	0.44	5.2	0.70	6.1	0.81	5.3	90	1.04	4.8

**Table 4**  
**Wave Data (concluded)**

Aug 1997											
Day	Hour	641		625		3111			630		
		Pressure Gauge Hmo, m	Tp, sec	Baylor Gauge Hmo, m	Tp, sec	8 Meter Array Hmo, m	Tp, sec	Dir, TN	Waverider Hmo, m	Tp, sec	
21	0100	0.31	5.4	0.70	5.9	0.66	6.2	74	1.00	5.9	
	0700	0.32	5.1	0.57	6.0	0.57	5.6	104	0.72	5.3	
	1300	0.26	7.4	0.43	7.0	0.46	6.6	74	0.52	7.2	
	1900	0.29	7.0	0.46	6.8	0.54	7.6	74	0.69	7.7	
22	0100	0.21	8.9	0.34	7.6	0.41	8.2	70	0.49	8.4	
	0700	0.28	7.8	0.44	8.1	0.51	8.2	108	0.59	7.7	
	1300	0.31	7.6	0.51	7.2	0.54	7.6	104	0.70	7.2	
	1900	0.32	6.8	0.48	6.8	0.55	7.1	104	0.69	6.7	
23	0100	0.31	7.4	0.46	7.6	0.47	8.2	68	0.59	7.2	
	0700	0.32	7.8	0.57	8.1	0.60	8.2	64	0.72	7.7	
	1300	0.46	4.5	0.57	9.2	0.57	8.9	54	0.71	8.4	
	1900	0.30	8.6	0.46	8.6	0.49	7.6	62	0.61	8.4	
24	0100	0.30	7.6	0.46	7.4	0.46	7.6	106	0.58	7.2	
	0700	0.21	7.0	0.43	8.3	0.41	7.1	104	0.46	7.2	
	1300	0.29	8.3	0.44	8.9	0.42	8.2	64	0.54	8.4	
	1900	0.26	8.6	0.50	10.3	0.47	8.9	96	0.54	9.1	
25	0100	0.44	8.1	0.67	8.3	0.66	8.2	104	0.75	9.1	
	0700	0.48	7.8	0.86	7.6	0.82	7.6	106	1.03	7.2	
	1300	0.62	7.6	1.00	5.1	1.00	7.6	106	1.23	7.7	
	1900	0.51	6.8	0.95	7.4	0.92	6.6	76	1.14	7.2	
26	0100	0.52	4.9	0.89	7.6	0.93	7.1	74	1.11	6.3	
	0700	0.41	5.4	0.87	8.1	0.85	7.6	72	0.95	7.7	
	1300	0.47	4.6	0.82	8.8	inoperative			0.97	7.7	
	1900	0.41	8.9	0.82	8.9	0.83	8.2	68	0.87	5.6	
27	0100	0.49	5.1	0.76	6.8	0.80	7.6	68	1.01	7.7	
	0700	0.37	8.3	0.71	8.3	0.71	8.2	66	0.85	7.7	
	1300	0.44	7.8	0.77	7.8	0.82	8.2	66	1.01	7.2	
	1900	0.43	7.6	0.88	8.6	0.90	8.9	86	1.04	8.4	
28	0100	0.44	7.8	0.83	8.6	0.87	8.9	70	0.96	10.1	
	0700	0.38	8.1	0.75	8.9	0.76	8.9	86	0.90	6.3	
	1300	0.41	7.4	0.81	8.3	inoperative			0.90	7.7	
	1900	0.40	7.8	0.70	8.1	0.75	8.2	104	0.84	8.4	
29	0100	0.38	8.1	0.59	7.8	0.69	8.2	78	0.79	8.4	
	0700	0.31	8.3	0.55	8.3	0.57	8.2	108	0.70	8.4	
	1300	0.36	8.1	0.62	8.3	0.64	8.2	70	0.66	7.7	
	1900	0.41	4.2	0.57	7.8	0.62	7.6	66	0.76	7.7	
30	0100	0.42	4.2	0.56	14.3	0.63	13.6	96	0.77	4.1	
	0700	0.36	14.3	0.48	14.3	0.51	13.6	102	0.67	13.4	
	1300	0.30	13.5	0.49	13.5	0.51	13.6	100	0.62	13.4	
	1900	0.36	13.5	0.51	9.9	0.52	13.6	80	0.63	12.6	
31	0100	0.29	12.9	0.52	12.9	0.54	9.8	100	0.66	12.6	
	0700	0.33	9.5	0.48	9.2	0.53	9.8	68	0.65	10.1	
	1300	0.28	9.2	0.56	9.2	0.55	8.9	70	0.63	9.1	
	1900	0.32	8.3	0.51	9.5	0.51	8.9	66	0.64	10.1	
Mean		0.32	8.0	0.54	8.0	0.57	8.2	78	0.70	7.8	
Std dev		0.15	2.6	0.20	2.1	0.20	1.9	33	0.24	2.0	

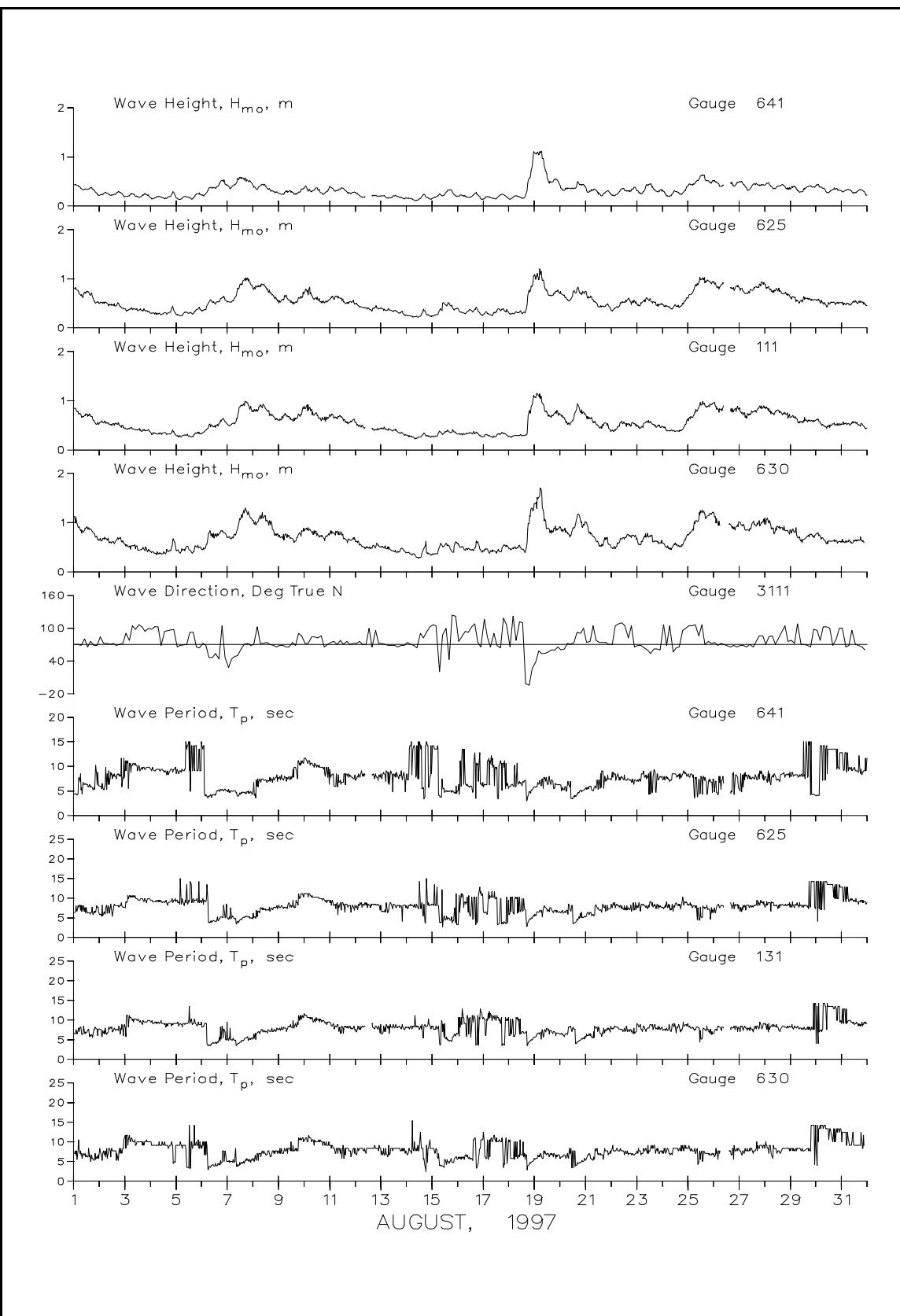


Figure 5. Wave Heights and Periods

# Current Data

## 4

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Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

**Table 5**  
**Current Meter Data - Gauge 3539**

AUGUST 1997																	
		Cross	Long		Cross	Long		Cross	Long								
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100					1300						22	100				
	700					1900							700				
	1300						12	100				1300					
	1900							700				1900					
2	100	inoperative				1300		inoperative				23	100	inoperative			
	700					1900							700				
	1300						13	100				1300					
	1900							700				1900					
3	100					1300						24	100				
	700					1900							700				
	1300						14	100				1300					
	1900							700				1900					
4	100					1300						25	100				
	700					1900							700				
	1300						15	100				1300					
	1900							700				1900					
5	100	inoperative				1300		inoperative				26	100	inoperative			
	700					1900							700				
	1300						16	100				1300					
	1900							700				1900					
6	100					1300						27	100				
	700					1900							700				
	1300						17	100				1300					
	1900							700				1900					
7	100					1300						28	100				
	700					1900							700				
	1300						18	100				1300					
	1900							700				1900					
8	100					1300						29	100				
	700					1900							700				
	1300						19	100				1300					
	1900							700				1900					
9	100					1300						30	100				
	700					1900							700				
	1300						20	100				1300					
	1900							700				1900					
10	100	inoperative				1300		inoperative				31	100	inoperative			
	700					1900							700				
	1300						21	100				1300					
	1900							700				1900					
11	100					1300							1300				
	700					1900							1900				

KEY:

+cross-shore = offshore, cm/sec  
 -cross-shore = onshore, cm/sec  
 +longshore = south, cm/sec  
 -longshore = north, cm/sec  
 Speed = Resultant speed, cm/sec  
 Dir = Resultant direction, degrees true north

**Table 6**  
**Visually Observed Current Data**

Aug 1997												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-5	12	13	184	-5	15	16	177	South	20	N	
2	-6	-20	21	323	-5	-23	24	329	South	18	N	
3	22	-22	31	25	19	-32	37	11	South	41	N	
4	7	-28	29	354	-4	-36	36	334	South	11	N	
5	3	27	27	154	4	13	14	143	North	8	S	
6	-3	55	55	163	-20	68	71	177	North	56	S	
7	-7	16	18	184	-9	47	48	171	North	24	S	
8	-5	18	19	177	4	-8	9	4	South	32	N	
9	-1	-7	7	331	-5	-51	51	334	South	40	N	
10	-8	-55	56	331	9	-47	48	351	South	26	N	
11	-7	-24	25	323	5	-34	34	349	South	24	N	
12	30	-34	46	22	19	-8	20	47	South	27	N	
13	24	30	39	70	21	-27	34	19	no observation			
14	11	-18	21	11	0	-41	41	340	South	3	N	
15	8	20	22	138	0	-18	18	340	South	9	N	
16	6	-13	15	7	-24	-41	47	309	South	9	N	
17	16	-8	18	43	10	-34	35	357	South	5	N	
18	20	-9	22	46	11	-38	40	357	South	17	N	
19	-8	55	56	169	-46	102	111	184	North	46	S	
20	-10	-34	35	323	-41	-68	79	309	South	30	N	
21	15	10	18	70	0	-7	7	340	South	76	N	
22	-5	18	19	177	-28	-47	55	309	South	24	N	
23	-10	68	68	169	-14	-30	33	316	South	9	N	
24	-4	36	36	166	21	-47	51	4	South	5	N	
25	-6	5	8	210	-30	-102	106	323	South	55	N	
26	-10	24	26	182	11	-76	77	349	South	21	N	
27	-8	17	19	187	-23	19	30	210	North	4	N	
28	0	38	38	160	-4	14	14	177	North	37	N	
29	6	10	12	129	-17	-87	89	329	South	12	N	
30	0	68	68	160	-9	29	30	177	North	18	S	
31	0	28	28	160	0	19	19	160	North	24	N	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

# Visual Observations

## 5

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Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

**Table 7**  
**Visual Observations**

Aug 1997							
Day	Time	Wave Approach Angle at Pier End (degrees from True N)		Water Characteristics at Pier End			
		Primary	Secondary	Surf Zone	Width, m	Temp.,C	Density g/cc
1	0622	100		53	23.9	1.0186	2.1
2	0848	105		45	25.6	1.0184	4.6
3	1015	85		30	22.8	1.0227	1.8
4	0606	110		19	23.3	1.0225	3.7
5	0610	95		19	20.0	1.0240	2.7
6	0618	20		37	24.7	1.0195	3.0
7	0653	45	No	33	24.7	1.0196	3.0
8	0556	55		53	24.4	1.0198	2.4
9	0654	95		29	24.4	1.0198	3.7
10	0929	95	secondary	38	24.7	1.0210	3.4
11	0557	100		52	24.4	1.0213	3.7
12	0715	85		38	23.5	1.0215	3.4
13	0706	100		23	19.4	1.0248	2.7
14	1150	90	waves	34	21.1	1.0244	4.9
15	0610	110		26	21.1	1.0242	4.0
16	0927	120		45	21.7	1.0244	4.9
17	0911	130		37	21.1	1.0244	3.7
18	0813	140		21	20.6	1.0246	4.6
19	0610	30		43	23.9	1.0207	3.7
20	0730	60		38	24.4	1.0200	3.7
21	0805	100		9	20.0	1.0246	1.5
22	0712	120		47	21.7	1.0244	3.0
23	0838	70		49	23.3	1.0216	2.7
24	0742	90		37	23.3	1.0208	4.0
25	0710	95		51	23.3	1.0208	3.4
26	0640	80		49	23.3	1.0204	2.7
27	0615	70		35	23.6	1.0206	2.1
28	0700	85		46	23.9	1.0200	2.7
29	0615	90		52	23.9	1.0222	5.5
30	0535	65		30	24.2	1.0215	2.7
31	0845	60		37	24.7	1.0200	5.5

# Water Levels

## 6

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Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

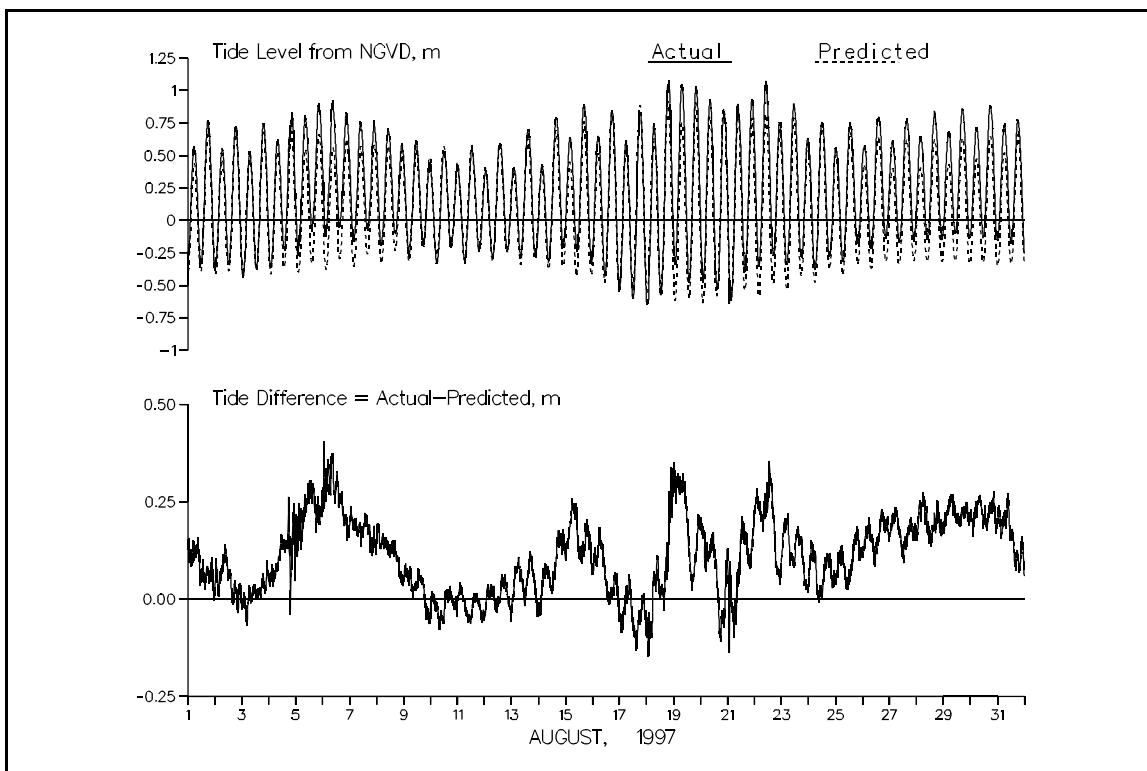


Figure 6. Water Level Variation

**Table 8**  
**Water Levels, m NGVD**

AUG 1997 Tide Levels																
Day	High			Low			Mean	Range	High			Low			Mean	Range
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day		
1	0512	0.57	1	0024	-0.26		0.23	0.83	16	1718	0.85	16	1106	-0.43	0.21	1.28
1	1806	0.77	1	1124	-0.35		0.21	1.12	17	0606	0.62	16	2336	-0.55	0.04	1.17
2	0630	0.56	2	0012	-0.39		0.10	0.94	17	1742	0.84	17	1200	-0.60	0.12	1.44
2	1842	0.73	2	1224	-0.34		0.18	1.06	18	0648	0.75	18	0012	-0.65	0.04	1.39
3	0700	0.53	3	0112	-0.44		0.04	0.97	18	1948	1.08	18	1236	-0.57	0.26	1.65
3	1900	0.75	3	1254	-0.37		0.19	1.13	19	0742	1.05	19	0200	-0.34	0.37	1.40
4	0800	0.62	4	0142	-0.37		0.14	0.99	19	1954	1.03	19	1354	-0.48	0.28	1.51
4	2030	0.83	4	1412	-0.23		0.30	1.06	20	0818	0.93	20	0206	-0.48	0.23	1.41
5	0806	0.81	5	0212	-0.27		0.29	1.08	20	2042	0.81	20	1442	-0.54	0.15	1.35
5	2024	0.90	5	1406	-0.08		0.41	0.98	21	0900	0.90	21	0154	-0.64	0.14	1.54
6	0848	0.93	6	0248	-0.13		0.40	1.05	21	2154	0.93	21	1536	-0.40	0.28	1.33
6	2054	0.83	6	1448	-0.06		0.38	0.89	22	1018	1.08	22	0400	-0.35	0.37	1.43
7	0930	0.76	7	0354	-0.17		0.29	0.93	22	2200	0.75	22	1636	-0.28	0.25	1.03
7	2148	0.77	7	1612	-0.08		0.32	0.85	23	1054	0.90	23	0436	-0.34	0.28	1.24
8	1000	0.71	8	0354	-0.20		0.26	0.91	23	2330	0.63	23	1754	-0.28	0.18	0.92
8	2224	0.59	8	1700	-0.10		0.23	0.70	24	1200	0.75	24	0548	-0.38	0.20	1.13
9	1054	0.62	9	0430	-0.28		0.17	0.89	25	0030	0.56	24	1806	-0.28	0.15	0.84
9	2306	0.44	9	1724	-0.19		0.12	0.63	25	1312	0.75	25	0642	-0.32	0.23	1.07
10	1218	0.53	10	0512	-0.34		0.11	0.87	26	0136	0.58	25	2006	-0.18	0.20	0.76
11	0006	0.44	10	1800	-0.21		0.11	0.64	26	1436	0.80	26	0736	-0.22	0.30	1.02
11	1242	0.55	11	0600	-0.33		0.11	0.88	27	0306	0.62	26	2042	-0.14	0.25	0.76
12	0100	0.38	11	1854	-0.24		0.08	0.62	27	1530	0.79	27	0848	-0.17	0.31	0.96
12	1336	0.59	12	0712	-0.30		0.15	0.89	28	0348	0.65	27	2154	-0.16	0.26	0.81
13	0230	0.40	12	2006	-0.24		0.10	0.64	28	1606	0.84	28	1000	-0.15	0.34	0.99
13	1442	0.70	13	0748	-0.29		0.21	0.99	29	0506	0.69	28	2224	-0.15	0.27	0.84
14	0306	0.44	13	2118	-0.29		0.08	0.72	29	1648	0.87	29	1054	-0.10	0.37	0.97
14	1542	0.80	14	0854	-0.32		0.24	1.12	30	0530	0.72	29	2312	-0.14	0.29	0.86
15	0400	0.64	14	2206	-0.20		0.22	0.85	30	1730	0.88	30	1112	-0.14	0.38	1.02
15	1636	0.89	15	1012	-0.24		0.32	1.13	31	0624	0.75	31	0018	-0.16	0.29	0.91
16	0448	0.65	15	2324	-0.34		0.17	0.99	31	1806	0.78	31	1218	-0.18	0.30	0.96

# Bathymetry

## 7

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A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in June and the survey(s) in August on profile line 188, located 517 m south of the pier.

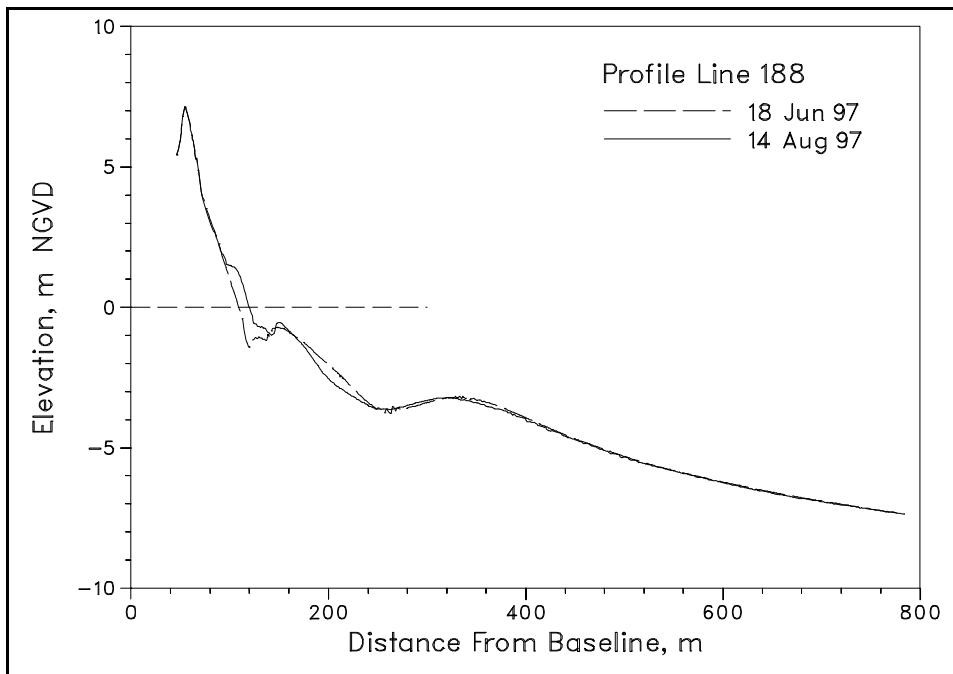


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1997. Cross-hatched areas indicate changes to the annual envelope which occurred in August.

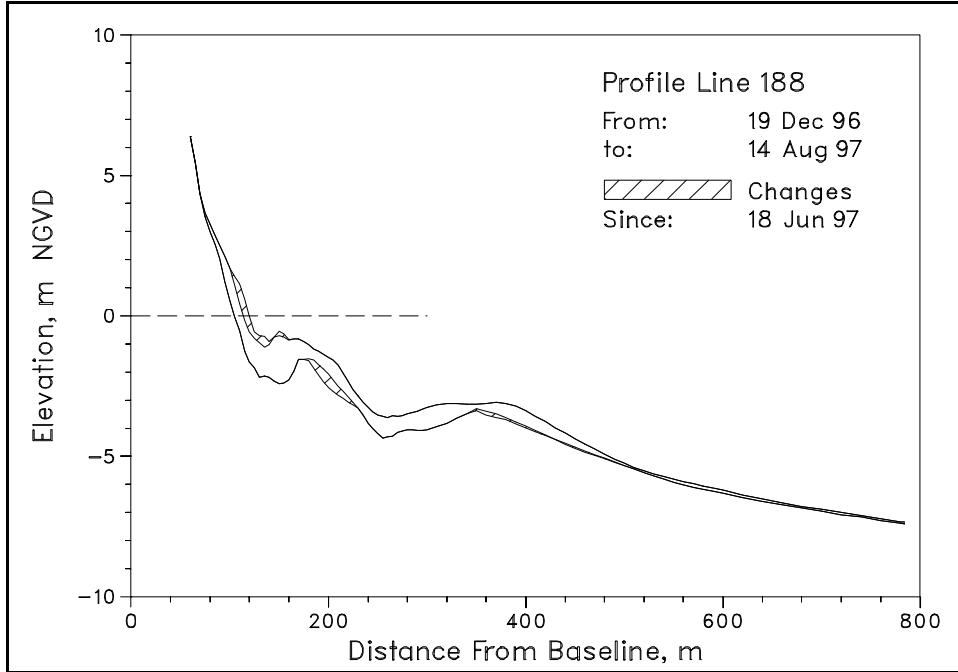


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 15 August. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

